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Specifications for and Classification of Brick

Abstract: This *Technical Note* describes the predominant-consensus standard specifications for brick and the various classifications used in each. Specific requirements — including physical properties, appearance features and coring — are described. Additional requirements for each brick specification also are covered.

Key Words: appearance, ASTM standards, brick, chippage, classification, CSA standard, dimensions, distortion, durability, exposure, grade, physical properties, specification, tolerances, type, use.

SUMMARY OF RECOMMENDATIONS:

- Identify the appropriate brick specification for the intended use
- Specify each classification in the specification or verify that the default classification is valid
- Specify each required action of the purchaser and specifier
- Evaluate and specify any optional requirement
- Use requirements in consensus-based specifications; deviate from them only with consideration of effect on performance and cost

INTRODUCTION

Brick selection is made according to the specific application in which the brick will be used. Standards for brick cover specific uses of brick and classify the brick by performance characteristics. The performance criteria include strength, durability and aesthetic requirements. Selection of the proper specification and classification within that specification, along with proper design and construction, should result in expected performance.

ASTM International (ASTM) publishes the most widely accepted standards on brick. These standards are voluntary consensus standards that are reviewed and updated periodically to contain the most recent information. All have been through a thorough review process by a balanced committee of interested ASTM members classified as producers, users and general interest. All of the model building codes in the United States reference ASTM standards for brick.

Standards used in Canadian building codes are prepared by the Canadian Standards Association (CSA). The process used to prepare and revise CSA standards is similar to ASTM's. The sole CSA standard for brick, A82 *Fired Masonry Brick Made from Clay or Shale*, is similar in content to the ASTM standards for face brick and hollow brick. It also includes test methods.

This *Technical Note* identifies the standards for brick and the specific requirements for its various classifications. Other *Technical Notes* in this series address the fundamentals of brick manufacturing and the proper selection of brick.

BRICK SPECIFICATIONS

Depending on its use, brick is covered by one of several specifications. See Table 1. Because firebox brick, chemical resistant brick, sewer and manhole brick, and industrial floor brick are special uses, they will not be addressed in this *Technical Note*.

TABLE 1
Specifications for Brick

Title of Specification	ASTM Designation[1]	CSA Designation[2]
Building Brick	C 62	—
Facing Brick	C 216	A82
Hollow Brick	C 652	A82
Thin Veneer Brick Units Made from Clay or Shale	C 1088	—
Pedestrian and Light Traffic Paving Brick	C 902	—
Heavy Vehicular Paving Brick	C 1272	—
Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units	C 126	—
Glazed Brick, Single Fired	C 1405	—
Firebox Brick, Residential Fireplaces	C 1261	—
Chemical-Resistant Masonry Units	C 279	—
Sewer and Manhole Brick	C 32	—
Industrial Floor Brick	C 410	—

1. ASTM International, 100 Bar Harbor Drive, West Conshohocken, PA 19428.
2. Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6 Canada.

Beginning with the 2007a edition of ASTM C 216, an appendix has been added. The appendix is designed to explain the specification, noting subtleties and relationships that might not otherwise be clear. In many instances the use of brick is similar to the title of its ASTM specification.

Facing Brick

Facing brick are intended for use in both structural and nonstructural masonry, including veneer, where appearance is a requirement.

Hollow Brick

Hollow brick are used as either building or facing brick but have a greater void area. Most hollow brick are used as facing brick in anchored veneer. Hollow brick with very large cores are used in reinforced brickwork and contain steel reinforcement and grout.

Building Brick

Building brick are intended for use in both structural and nonstructural brickwork where appearance is not a requirement. Building brick are typically used as a backing material.

Thin Brick

Thin veneer brick have normal face dimensions but a reduced thickness. They are used in adhered veneer applications.

Paving Brick

Paving brick are intended for use as the wearing surface on clay paving systems. As such they are subject to pedestrian and light or heavy vehicular traffic.

Glazed Brick

Glazed brick have a ceramic glaze finish fused to the brick body. The glaze can be applied before or after the firing of the brick body. These brick may be used as structural or facing components in masonry.

CLASSIFICATIONS

There are several classifications used in each standard. Classifications include grade, class, type, application and use. The criteria for these classifications may include exposure or use conditions; appearance items; physical properties needed for performance; tolerances on dimensions and distortion; chippage; and void area.

Brick qualify for a particular classification based on their properties after manufacturing. While most brick can be manufactured to attain all the attributes desired by a user, certain attributes may be dictated by the production method, durability classification or appearance classification designated by the user. For example, a molded brick cannot be made to meet the classification for the tightest dimensional tolerances since the production method uses a higher percentage of water that may result in greater shrinkage. Brick manufactured by the extrusion process can be made to meet the classification for tight or loose dimensional tolerances.

When specifying brick each classification should be designated. Some ASTM brick specifications default to a certain classification if it is not designated. The default classification may not be suitable for the intended use. Table 2 contains a listing of the classifications in ASTM and CSA brick specifications.

TABLE 2
Classifications in Specifications for Brick

	Classification			
	Durability	**Appearance**	**Void Area**	**Use**
ASTM Specification				
C 62 Building Brick	Grade	None	None	None
C 216 Facing Brick	Grade	Type	None	None
C 652 Hollow Brick	Grade	Type	Class	None
C 1088 Thin Veneer Brick	Grade	Type	None	None
C 902 Pedestrian and Light Traffic Paving Brick	Class and Type	Application	None	Type
C 1272 Heavy Vehicular Paving Brick	Type	Application	None	Type
C 126 Ceramic Glazed Facing Brick	None	Grade and Type	None	None
C 1405 Single Fired Glazed Brick	Class	Grade and Type	Division	None
CSA Specification				
A82 Fired Masonry Brick Made from Clay or Shale	Grade	Type	None[1]	None

1. No classification given, but solid, cored and hollow brick are defined. See Void Area.

Durability and Exposure

Since the environmental and service conditions that brick are subjected to vary, each brick specification classifies brick for its specific durability. The classification is based on the severity of weather and the exposure of the brick. The classification assigned to the brick is typically based on physical properties of the brick. See *Technical Note* 9B for selection of the appropriate level of durability. The durability classifications for each specification are listed in Table 3.

TABLE 3
Durability Classifications

	Durability Classification	More Severe Exposure		Less Severe Exposure
ASTM Specification				
C 62 Building Brick	Grade	SW	MW	NW
C 216 Facing Brick	Grade	SW		MW
C 652 Hollow Brick	Grade	SW		MW
C 1088 Thin Veneer Brick	Grade	Exterior		Interior
C 902 Pedestrian and Light Traffic Paving Brick	Class	SX	MX	NX
	Type	I	II	III
C 1272 Heavy Vehicular Paving Brick	Type	F		R
C 126 Ceramic Glazed Facing Brick	None		—	
C 1405 Single Fired Glazed Brick	Class	Exterior		Interior
CSA Specification				
A82 Fired Masonry Brick Made from Clay or Shale	Grade	Exterior (EG)		Interior (IG)

For durability classifications the letters S, M and N in C 62, C 216, C 652 and C 902 indicate the following exposure conditions:

S indicates severe weathering.
M indicates moderate weathering.
N indicates negligible or no weathering.

Physical Property Requirements. The physical property requirements in most specifications are compressive strength, water absorption and saturation coefficient. These properties must be determined in accordance with ASTM C 67, *Standard Methods of Sampling and Testing Brick and Structural Clay Tile* [Ref. 1] or CSA A82 [Ref. 3]. The minimum compressive strength, maximum water absorption and maximum saturation coefficient are used in combination to predict the durability of the bricks in use. The saturation coefficient, also referred to as the C/B ratio, is the ratio of 24-hour cold water absorption to the five-hour boiling absorption. The physical property requirements for each standard are listed in Table 4.

Some brick are durable but cannot be classified under the physical requirements shown in Table 4. Using alternates and alternatives in the specifications allows brick that are known to perform well to meet the durability requirement. A brick qualifying for a classification by an alternate or alternative does not signify that it is of a lower quality.

The Absorption Alternate is found in ASTM C 62, C 216, C 652, C 1088, C 902 and C 1405. The Freezing and Thawing Alternative is found in ASTM C 62, C 216, C 652, C 1088, C 902, C 1272 and C 1405. The Low Weathering Index Alternative is found in ASTM C 62, C 216 and C 1088. CSA A82 includes a freeze-thaw test as an alternative if the brick does not meet the physical property requirements. Other unit specifications include alternates as well. These are discussed in the Additional Requirements section.

Absorption Alternate- The saturation coefficient requirement does not apply, provided the cold water absorption of any single brick of a random sample of five brick does not exceed 8 percent.

TABLE 4
Physical Properties in Brick Specifications

		Minimum Compressive Strength, Gross Area[1] psi (MPa)		Maximum Cold Water Absorption, %		Maximum Five-Hour Boiling Absorption, %		Maximum Saturation Coefficient		Minimum Breaking Load, lb/in. (kN/mm)	
		Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual
ASTM Specification and Classification											
C 62 Grade	SW	3000 (20.7)	2500 (17.2)	—	—	17.0	20.0	0.78	0.80	—	—
	MW	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—
	NW	1500 (10.3)	1250 (8.6)	—	—	No limit	No limit	No limit	No limit	—	—
C 216 Grade	SW	3000 (20.7)	2500 (17.2)	—	—	17.0	20.0	0.78	0.80	—	—
	MW	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—
C 652 Grade	SW	3000 (20.7)	2500 (17.2)	—	—	17.0	20.0	0.78	0.80	—	—
	MW	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—
C 1088 Grade	Ext.	—	—	—	—	17.0	20.0	0.78	0.80	—	—
	Int.	—	—	—	—	22.0	25.0	0.88	0.90	—	—
C 902 Class	SX	8000 [4000][2] (55.2) [(27.6)][2]	7000 [3500][2] (48.3) [(24.1)][2]	8.0 [16.0][2]	11.0 [18.0][2]	—	—	0.78	0.80	—	—
	MX	3000 (20.7)	2500 (17.2)	14.0	17.0	—	—	No limit	No limit	—	—
	NX	3000 (20.7)	2500 (17.2)	No limit	No limit	—	—	No limit	No limit	—	—
C 1272 Type	F	10,000 (69.0)	8800 (60.7)	6.0	7.0	—	—	—	—	475 (83)	333 (58)
	R	8000 (55.2)	7000 (48.3)	6.0	7.0	—	—	—	—	—	—
C 126 Coring	Vert.	3000 (20.7)	2500 (17.2)	—	—	—	—	—	—	—	—
	Horiz.	2000 (13.8)	1500 (10.3)	—	—	—	—	—	—	—	—
C 1405 Class	Ext.	6000 (41.4)	5600 (34.8)	—	7.0	—	—	0.78	0.80	—	—
	Int.	3000 (20.7)	2500 (17.2)	—	—	—	—	—	—	—	—
CSA Specification and Classification											
A82	Ext.	3000 (20.7)	2500 (17.2)	—	8.0[3]	—	17.0	—	0.78[3]	—	—
	Int.	2500 (17.2)	2200 (15.2)	—	—	22.0	25.0	0.88	0.90	—	—

1. Brick in bearing position or loaded in the same direction as in service.
2. Numbers in brackets are for molded brick and apply provided the requirements for saturation coefficient are met.
3. Either of these requirements must be met, not both.

Freezing and Thawing Alternative- The requirements for five-hour boiling water absorption and saturation coefficient do not apply, provided a sample of five brick, meeting the strength requirements, passes the freezing and thawing test as described in the Rating section of the Freezing and Thawing test procedures of ASTM C 67 with a weight loss not greater than 0.5 percent in dry weight of any individual brick (for Grade SW). Unlike ASTM C 67, CSA A 82 stipulates that brick must be kept in a frozen state during any interruption of the freeze-thaw test.

Low Weathering Index Alternative- If the brick are intended for use where the weathering index is less than 50 and have a minimum average compressive strength of 2500 psi (17.2 MPa), the requirements given for five-hour boiling water absorption and for saturation coefficient shall not apply.

Consult the appropriate ASTM specification for specific alternates.

Appearance

Classification related to the appearance may include limits tolerances on dimensions, distortion, out-of-square and chippage. The appearance classification is established on the size and precision attained in manufacturing. The classifications for appearance of brick for each specification are listed in Table 5, and requirements for size variation, distortion and chippage are listed in Table 6, Table 7 and Table 8, respectively. There are no color-related tolerances in the ASTM standards for brick. Those are dictated by the sample panel or project specification.

TABLE 5
Appearance Classifications

	Appearance Classifications	More Stringent Requirements		Less Stringent Requirements
ASTM Specification				
C 62 Building Brick	None	—		
C 216 Facing Brick	Type	FBX	FBS	FBA
C 652 Hollow Brick	Type	HBX	HBS HBA	HBB
C 1088 Thin Veneer Brick	Type	TBX	TBS	TBA
C 902 Pedestrian and Light Traffic Paving Brick	Application	PX	PS	PA
C 1272 Heavy Vehicular Paving Brick	Application	PX	PS	PA
C 126 Ceramic Glazed Facing Brick	Grade	SS		S
	Type	II		I
C 1405 Single Fired Glazed Brick	Grade	SS		S
	Type	II		I
CSA Specification				
A82 Fired Masonry Brick Made from Clay or Shale	Type	X	S	A

For appearance classifications the letters X, S and A have the following meanings:

X indicates extreme or extra control in the criteria.
S indicates standard production.
A indicates architectural or aesthetic criteria that must be specified and in many specifications must be less stringent than the S designation.

Dimensional Tolerances. Variations in raw materials and the manufacturing process will result in brick that vary in size. Permitted size variation is based on the brick classification and the relative dimensional range measured. These permitted variations in size are listed in Table 6A, Table 6B and Table 6C. The variation is plus or minus from the specified dimension. Size variation becomes important when vertical alignment of brick (stack bond) is used, when bands of brick from different production runs are combined, or when a short horizontal extent of brickwork is constructed, such as between closely spaced window openings.

TABLE 6A
Dimensional Tolerances for ASTM C 216 and CSA A82[1]

Specified Dimension or Average Brick Size in Job Lot Sample, in. (mm)	Maximum Permissible Variation, in. (mm), plus or minus from:				
	Column A (for Specified Dimension)		Column B (for Average Brick Size in Job Lot Sample)[2]		
	Type FBX	Type FBS	Type FBX	Type FBS Smooth[3]	Type FBS Rough[4]
3 (76) and under	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)	1/16 (1.6)	3/32 (2.4)
Over 3 to 4 (76 to 102), inclusive	3/32 (2.4)	1/8 (3.2)	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
Over 4 to 6 (102 to 152), inclusive	1/8 (3.2)	3/16 (4.8)	3/32 (2.4)	3/32 (2.4)	3/16 (4.8)
Over 6 to 8 (152 to 203), inclusive	5/32 (4.0)	1/4 (6.4)	3/32 (2.4)	1/8 (3.2)	1/4 (6.4)
Over 8 to 12 (203 to 305), inclusive	7/32 (5.6)	5/16 (7.9)	1/8 (3.2)	3/16 (4.8)	5/16 (7.9)
Over 12 to 16 (305 to 406), inclusive	9/32 (7.1)	3/8 (9.5)	3/16 (4.8)	1/4 (6.4)	3/8 (9.5)

1. Dimensional tolerances for Type FBA and A in C 216 and A82, respectively, shall be as specified by the purchaser, but not more restrictive than Type FBS and S (Rough), respectively.
2. Lot size shall be determined by agreement between purchaser and seller. If not specified, lot size shall be understood to include all brick of one size and color in the job order.
3. Type FBS Smooth brick have relatively fine texture and smooth edges, including wire cut surfaces. These definitions relate to dimensional tolerances only.
4. Type FBS Rough bricks are molded brick or extruded brick with textured, rounded or tumbled edges or faces. These definitions apply to dimensional tolerances only.

TABLE 6B
Dimensional Tolerances

ASTM Specification and Classification		Maximum Permissible Variation, in. (mm), plus or minus					
		3 (76) and under	Over 3 to 4 (102) inclusive	Over 4 to 6 (152) inclusive	Over 6 to 8 (204) inclusive	Over 8 to 12 (306) inclusive	Over 12 to 16 (408) inclusive
C 62		3/32 (2.4)	1/8 (3.2)	3/16 (4.8)	1/4 (6.4)	5/16 (8.0)	3/8 (9.5)
C 652	HBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	7/32 (5.6)	9/32 (7.1)
	HBS and HBB	3/32 (2.4)	1/8 (3.2)	3/16 (4.8)	1/4 (6.4)	5/16 (7.9)	3/8 (9.5)
	HBA	As specified by the purchaser, but not more restrictive than HBS and HBB					
C 1088	TBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	7/32 (5.6)	9/32 (7.2)
	TBS	3/32 (2.4)	1/8 (3.3)	3/16 (4.8)	1/4 (6.4)	5/16 (8.0)	3/8 (9.5)
	TBA	As specified by the purchaser					
C 126		See ASTM C 126					
C 902 and C 1272	PX	1/16 (1.6)	3/32 (2.4)	—	1/8 (3.2)	7/32 (5.6)	—
	PS	1/8 (3.2)	3/16 (4.8)	—	1/4 (6.4)	5/16 (8.0)	—
	PA	No limit	No limit	—	No limit	No limit	—

TABLE 6C
Dimensional Tolerances for ASTM C 1405

Specified Dimension or Average Brick Size in Job Lot Sample, in. (mm)	Maximum Permissible Variation in Dimensions, in. (mm) plus or minus from:			
	Column A (for Specified Dimension)		Column B (for Average Brick Size in Job Lot Sample)[1]	
	Grade S	Grade SS	Grade S	Grade SS
3 (76) and under	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)
Over 3 to 4 (76-102), inclusive	3/32 (2.4)	1/16 (1.6)	1/16 (1.6)	1/16 (1.6)
Over 4 to 6 (102-152), inclusive	1/8 (3.2)	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)
Over 6 to 8 (152-203), inclusive	5/32 (4.0)	1/16 (1.6)	3/32 (2.4)	1/16 (1.6)
Over 8 to 12 (203-305), inclusive	7/32 (5.6)	1/16 (1.6)	1/8 (3.2)	1/16 (1.6)
Over 12 to 16 (305-406), inclusive	9/32 (7.1)	1/16 (1.6)	3/16 (4.8)	1/16 (1.6)

1. Lot size shall be determined by agreement between purchaser and seller. If not specified, lot size shall be understood to include all brick of one size and color in the job order.

TABLE 7
Distortion Tolerances

		Maximum Permissible Distortion, in. (mm)		
		8 (204) and under	Over 8 to 12 (306), inclusive	Over 12 to 16 (408), inclusive
ASTM Specification and Classification				
C 62		No limit	No limit	No limit
C 216	FBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	FBS	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
	FBA	As specified by the purchaser		
C 652	HBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	HBS	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
	HBA	As specified by the purchaser		
C 1088	TBX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	TBS	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
	TBA	As specified by the purchaser		
C 902 and C1272	PX	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
	PS	3/32 (2.4)	1/8 (3.3)	5/32 (4.0)
	PA	No limit.		
C 126		Special requirements – see ASTM C 126		
C 1405	SS	1/16 (1.6)	3/32 (2.4)	3/32 (2.4)
	S	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
CSA Specification and Classification				
A82	X	(1.5)	(2.5)	(3.0)
	S	(2.5)	(3.0)	(4.0)
	A	As specified by purchaser, but not more restrictive than Type S (Rough)		

Distortion. Permitted distortion, or warpage, of brick is listed in Table 7. The amount of distortion is based on the brick specification and face dimension. Distortion may be convex or concave and may be in the plane of the wall or perpendicular to it, as illustrated in Figure 1. Other terms for distortion are “bowed” or “banana” brick. A brick that is over the distortion limitations is difficult to lay and is easily noticeable in the brickwork.

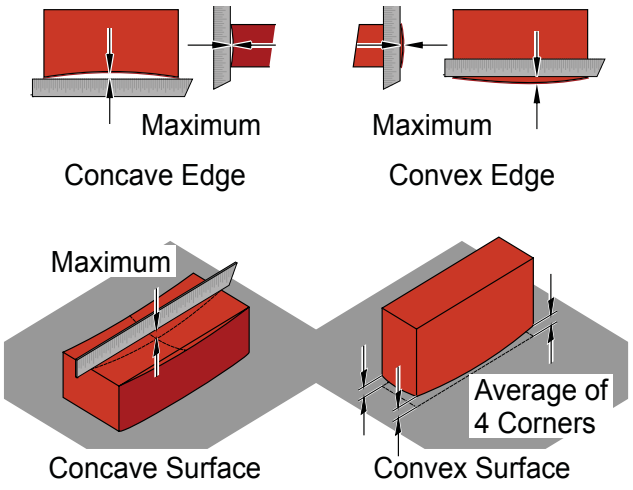


Figure 1
Distortion Measurements

Chippage. Brick may be damaged or chipped during packaging, shipping or on the job site. Limitations to the size and number of chips on individual brick are listed in Table 8. The amount of chippage is based upon the brick specification and classification.

A delivery of brick may contain up to 5 percent broken brick or brick chipped beyond the limits in Table 8. The chippage requirements in Table 8 are based on the remaining 95 percent of the shipment. The chips are measured from an edge or a corner, and the total length of these chips may not be greater than 10 percent of the perimeter of the face of the brick. Chips are more noticeable on brick that have a surface color different from the body of the brick. Chips on "through-body" color brick are less noticeable.

TABLE 8

Maximum Permissible Range of Chippage[1]

Specification and Type or Application						Percent Allowed	Chippage in From		Percent Allowed	Chippage in From	
ASTM C 216	ASTM C 652	ASTM C 1088	ASTM C 902	ASTM C 1272	CSA A82		Edge, in. (mm)	Corner, in. (mm)		Edge, in. (mm)	Corner, in. (mm)
FBX	HBX	TBX	—	—	X	95 to 100%	0 to 1/8 (0 to 3.2)	0 to 1/4 (0 to 6.4)	5% or less	1/8 to 1/4 (3.2 to 6.4)	1/4 to 3/8 (6.4 to 9.5)
FBS[2]	HBS[2]	TBS[2]	—	—	S[2]	90 to 100%	0 to 1/4 (0 to 6.4)	0 to 3/8 (0 to 9.5)	10% or less	1/4 to 5/16 (6.4 to 7.9)	3/8 to 1/2 (9.5 to 12.7)
FBS[3]	HBS[3]	TBS[3]	—	—	S[3]	85 to 100%	0 to 5/16 (0 to 7.9)	0 to 1/2 (0 to 12.7)	15% or less	5/16 to 7/16 (7.9 to 11.1)	1/2 to 3/4 (12.7 to 9.1)
FBA	HBA HBB	TBA	PA	PA[4]	A	As specified by the purchaser[5]					
—	—	—	PS	PS PX	—	100%	5/16 (7.9)	1/2 (12.7)	—	—	—
—	—	—	PX	—	—	100%	1/4 (6.4)	3/8 (9.5)	—	—	—

1. There are no chippage requirements for C 62, C 126 or C 1405.
2. Extruded brick with unbroken natural die finish face and dry-pressed brick.
3. Extruded brick with finished face sanded, combed, scratched, scarified, or broken by mechanical means such as wire cutting or wire brushing, and molded brick.
4. No limit.
5. Not more restrictive than FBS (Textured) in C 216 or HBS (altered).

ADDITIONAL REQUIREMENTS

Void Area

In ASTM standards brick are generally classified as solid or hollow. A solid brick is defined as a unit whose net cross-sectional area in every plane parallel to the bearing surface is 75 percent or more of its gross cross-sectional area measured in the same plane. Thus, a solid brick has a maximum coring or void area of 25 percent. A hollow brick is defined as a unit whose net cross-sectional area in every plane parallel to the bearing surface is less than 75 percent of its gross cross-sectional area measured in the same plane. A hollow brick has a minimum coring or void area greater than 25 percent, and a maximum of 60 percent. Brick are cored or frogged at the option of the manufacturer.

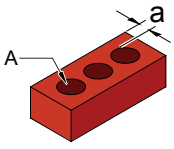
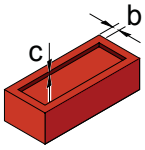
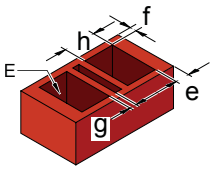
Cores. Holes in brick less than or equal to 1½ square inches (9.68 cm^2) in cross-sectional area, referred to as cores, are used to aid in the manufacturing process and shipping of brick. The cores permit better utilization of raw materials, create more uniform drying and firing of the brick, reduce the amount of fuel necessary to fire the brick and reduce shipping costs by reducing weight. Additional advantages, such as aiding in mechanical bond in a wall, easier laying of the brick, etc., also may result from brick manufactured with cores. Cores are found only in brick manufactured by the extrusion or dry-press process. Limits to the amount of coring allowed in brick, the distance from a core to a face, and web thickness where applicable are listed in Table 9.

Cells. Cells are similar to cores except that a cell is larger in minimum dimension and has a cross-sectional area greater than 1½ square inches (9.68 cm2). Some requirements for cells are shown in Table 9. Additional requirements for cells can be found in ASTM C 652, C 126 and C 1405 and CSA A82.

Frogs. Frogs are depressions in brick, usually located on one bed surface, and are included for the same reasons as cores and cells. Frogs are found in brick manufactured by the molded process. Panel frogs are limited to a specified depth and a specified distance from a face. Requirements for panel frogs are listed in Table 9. Deep frogs are depressions deeper than 3/8 in. (10 mm), and must conform to the requirements for coring, hollow spaces and void area of the applicable standard.

The Canadian Standards Association takes a different approach. CSA A82 defines a solid brick as one without cores, cells or frogs deeper than 3/8 in. (10 mm); cored brick as those of which the net cross-sectional area in any plane parallel to the bed face shall be at least 75 percent of the gross cross-sectional area measured in the same plane; and hollow brick as brick whose net cross-sectional area in a plane parallel to the bed face is not less than 40 percent and not more than 75 percent of its gross cross-sectional area measured in the same plane. Further, there is a required minimum dimension of 1/2 in. (6 mm) between cores; 1 in. (13 mm) between cells; and 3/4 in. (19 mm) to an edge from a core, cell or frog.

TABLE 9
Requirements for Void Areas[1]

ASTM Specification		Void Area, %	 Cores		 Frogs		 Cells				
			a	A	b	c	E	e	f	g	h
			in. (mm), min.	in.² (cm²), max.	in. (mm), min.	in. (mm), min.	in.² (cm²), max.	in. (mm), min.	in. (mm), min.	in. (mm), min.	in. (mm), min.
C 62		< 25	3/4 (19.1)	—	3/4 (19.1)	3/8 (9.5)	No Requirements for Cells				
C 216		< 25	3/4 (19.1)	—	3/4 (19.1)	3/8 (9.5)	No Requirements for Cells				
C 652[2]	H40V	> 25, ≤ 40	5/8 (16)	≤ 1½ (9.68)	5/8 (16)	3/8 (9.5)	< 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)	—
	H60V[3]	> 40, ≤ 60	5/8 (16)	≤ 1½ (9.68)	5/8 (16)	3/8 (9.5)	> 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)	—
C 1088		—	No Requirements for Cores, Frogs or Cells								
C 902		—	No Requirements for Cores, Frogs or Cells								
C 1272		—	Cores and Cells Not Permitted								
C 126[4]		—	No Requirements for Cores or Frogs				> 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)[5]	1/2 (13)
C 1405[2]	Solid	≤ 25	3/4 (19.1)	—	3/4 (19.1)	3/8 (9.5)	No Requirements for Cells				
	H40V	> 25, ≤ 40	5/8 (16)	1½ (9.68)	5/8 (16)	3/8 (9.5)	> 1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)	—
	H60V[3]	> 40, ≤ 60	—	5/8 (16)	1½ (9.68)	5/8 (16)	3/8 (9.5)	1½ (9.68)	3/4 (19.1)	3/4 (19.1)	1/2 (13)

1. Deep frogs shall meet coring requirements of the applicable specification (see ASTM C 62, C216, C 652 and C 1405).
2. Cored-shell and double-shell hollow brick shall meet additional coring requirements of applicable specification in ASTM C 652 and C 1405.
3. Based on 3 in. (76 mm) and 4 in. (102 mm) nominal width (for larger dimensions see C 652 and C 1405).
4. Cells shall meet additional requirements of ASTM C 126.
5. Web thickness in cored brick shall meet additional requirements of ASTM C 126.

Efflorescence

Efflorescence is a crystalline deposit of water-soluble salts that can form on the surface of some brickwork. The principal objection is an unsightly appearance, though it typically is not harmful to brick. The test for efflorescence is described in ASTM C 67 and CSA A82. Brick tested under C 67 are given a rating of “effloresced” or “not effloresced.” The specifier must invoke this part of the standard for the requirement of “not effloresced” to apply. CSA A82 also includes a rating of “slightly effloresced,” and it is this rating that must be met if efflorescence testing is invoked. Requirements on efflorescence are not included in C 62 and C 126.

Strength

Brickwork may be used as a structural material, so there may be instances when it is important to specify a minimum compressive strength of the brick. This possibility is noted in ASTM C 62, C 216, C 652 and C 1405. Most brick have compressive strengths considerably higher than the minimum compressive strengths required for durability and abrasion resistance.

Initial Rate of Absorption

The initial rate of absorption (IRA) is a measure of how quickly the brick will remove water from mortar spread on it. IRA is not a qualifying property or condition of brick in the ASTM or CSA specifications. IRA values may be of interest when selecting mortar and in use of the brick on the jobsite. If the purchaser wishes to learn the IRA of the brick, the IRA test must be requested. Initial rate of absorption information is included in ASTM C 62, C 216, C 652 and C 1405.

Sampling and Testing

All brick under ASTM specifications are sampled and tested in accordance with ASTM C 67. The purchaser designates the place of selection of the brick for testing when the order is placed. Brick for efflorescence testing must be sampled at the point of manufacturer. This is because the brick may be contaminated by efflorescing materials after leaving the brick plant. Brick are sampled and tested for compliance to their specification prior to use. ASTM C 126 and C 1405 include additional tests for properties of the glaze. These are described in the following section on Glazed Brick.

CSA A82 includes sampling and test methods as part of the standard.

Facing Brick, ASTM C 216 and CSA A82

An additional tolerance is found in the ASTM standard for solid facing brick specification and in CSA A82. The amount that the exposed face of a brick can be “out-of-square” is limited. This is more critical as brick height increases. The maximum permitted dimension for out-of-square of the exposed face of the brick in C 216 is 1/8 in. (3.2 mm) for Type FBS brick and 3/32 in. (2.4 mm) for Type FBX brick. Tolerances on out-of-square for Type FBA brick shall be specified by the purchaser.

CSA A82 contains similar requirements: Type S of 3.0 mm and Type X of 2.5 mm. Tolerances on out-of-square for Type A brick shall be specified be specified but shall not be more restrictive than for Type S (Rough) brick.

Paving Brick, ASTM C 902 and C 1272

Not only must paving brick conform to the physical properties required in Table 4, but they also must have additional alternatives for durability and must meet requirements for abrasion resistance.

Alternative Performance Requirements. If information on the performance of brick in a pavement subject to similar exposure and traffic conditions is documented, then the physical property requirements in Table 4 may be waived. This is identified as the Performance Alternative.

An optional test for the freeze and thaw test is ASTM C 88 *Test Method for Soundness of Aggregates by Use of Sodium Sulfate*. The sulfate soundness test, like the freeze and thaw test, is not required unless the paving brick do not meet the saturation coefficient and absorption requirements.

Abrasion Resistance. Since paving brick are used in a horizontal application and are exposed to traffic, they must meet a specified abrasion limit. Pedestrian and light traffic paving brick (C 902) are assigned a Type by the traffic or abrasion expected. Type I pavers are exposed to extensive abrasion, such as driveways or public entries. Type II pavers are exposed to high levels of pedestrian traffic, such as in stores, restaurant floors or exterior walkways. Type III pavers are exposed to light pedestrian traffic, such as floors or patios in homes.

Heavy vehicular paving brick (C 1272) are assigned a Type depending on their intended installation. Type R pavers are intended to be set in a mortar or asphalt setting bed supported by an adequate base. Type R pavers must be at least 2¼ in. (57.2 mm) thick. Type F pavers are intended to be set in a sand setting bed, with sand joints, and supported by an adequate base. Type F pavers must be at least 2⅝ in. (66.7 mm) thick. The abrasion requirements are the same for Type F and Type R pavers.

The abrasion resistance index can be determined in either of two ways: 1) by dividing the absorption by the compressive strength and multiplying by 100, or 2) by determining the volume abrasion loss in accordance with ASTM C 418 *Test Method for Abrasion Resistance of Concrete by Sandblasting*. The abrasion requirements are listed in Table 10.

TABLE 10
Abrasion Resistance Requirements for Pavers

ASTM Specification	Traffic Type	Abrasion Index, Max.	Volume Abrasion Loss, Max. (cm^3/cm^2)
C 902 Pedestrian and Light Traffic Paving Brick	Type I	0.11	1.7
	Type II	0.25	2.7
	Type III	0.50	4.0
C 1272 Heavy Vehicular Paving Brick	Types F and R	0.11	1.7

Glazed Brick, ASTM C 126 and C 1405

ASTM C 126 and C 1405 are specifications for glazed brick and contain requirements for properties of the glaze. These properties include imperviousness, opacity, resistance to fading, resistance to crazing, flame spread, fuel contribution and smoke density, toxic fumes, hardness, and abrasion resistance.

SUMMARY

This *Technical Note* identifies brick specifications used in the United States and Canada. Classification designations for each brick specification and the criteria used to qualify for them are explained. Potential performance issues can be minimized by designating the proper brick specification and applicable classifications based on the environmental and service conditions of the project.

> *The information and suggestions contained in this* Technical Note *are based on the available data and the experience of engineering staff and members of the Brick Industry Association. The information contained herein should be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information discussed in this* Technical Note *are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.*

REFERENCES

1. *Annual Book of ASTM Standards*, ASTM International, West Conshohocken, PA 2006:

Volume 04.02 – Concrete and Aggregate
- ASTM C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate
- ASTM C 418 Test Method for Abrasion Resistance of Concrete by Sandblasting

Volume 4.05 – Chemical Resistant Nonmetallic Materials; Vitrified Clay Pipe; Concrete Pipe; Fiber-Reinforced Cement Products; Mortars and Grouts; Masonry; Precast Concrete
- C 32, Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
- C 62, Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale)
- C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
- C 126, Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
- C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
- C 279, Standard Specification for Chemical-Resistant Masonry Units
- C 410, Standard Specification for Industrial Floor Brick
- C 652, Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
- C 902, Standard Specification for Pedestrian and Light Traffic Paving Brick
- C 1088, Standard Specification for Thin Veneer Brick Units Made from Clay or Shale
- C 1261, Standard Specification for Firebox Brick for Residential Fireplaces
- C 1272, Standard Specification for Heavy Vehicular Paving Brick
- C 1405, Standard Specification for Glazed Brick (Single Fired, Brick Units)

2. Borchelt, J. G., Danforth, L.. Jr., and Hunsicker, R., “Specifying Brick: Getting what you want for appearance and function,” *The Construction Specifier*, Construction Specifications Institute, Alexandria, VA, January 2006, pp. 20-28.
3. CSA A82, Fired Masonry Brick Made from Clay or Shale, Canadian Standards Association, Mississauga, Ontario, Canada, 2006.